

Lesson Title: The Physiological Effects of Caffeine

Objectives: SWBAT...

Expose goldfish to a quantity of caffeine that's comparable to a human dose by weight. Observe changes in behavior and swimming speed. Count gill movements before and after caffeine dose. Make a bar graph to compare gill movement before and after dosing.

Lesson duration: approx. 2 hours

Aim: Understand the physiological effects of caffeine using goldfish

Do Now: List as many caffeine-containing food items as you can think of

Materials:

- Student data collection sheets and graph paper
- Goldfish (one/group. \$0.10/each)
- Fish nets
- 1L beakers (one/group. Containing 600mL tank water)
- Stopwatch (one/group)
- Caffeine tablets (No Doz, Vivarin)
- Pill splitter/ razor
- Mortar and pestle for crushing pills
- 100mL beakers (one/group.)
- Stirring rods

Procedure:

1. Provide 30 mins. introductory information on caffeine, sources and doses, as well as fish anatomy and physiology to understand the location and function of the gills.
2. Divide class into groups. Each group is given a 1L beaker with a goldfish that has had at least one hour to acclimate. Caffeine pills contain 200mg caffeine, therefore by cutting the pill in quarters, each pill fragment contains 50mg caffeine. Crush the pill fragment with a mortar and pestle. In a 100mL beaker containing 50mL tap water, add the crushed pill and dissolve with the stirring rod.
3. Have the students note the location of the gill on their specimen, and observe its usual function. (Students are also encouraged to observe the fish's natural behavior, and to find a different parameter to measure in response to caffeine exposure; thus including experimental design in the lesson objective). One group member will be in charge of the stopwatch and will fulfill the role of time keeper. Another student will be the data recorder. All other group members will be responsible for counting gill movements for the duration of time as indicated by the time keeper.
4. On the timekeepers command, the number of gill movements over a 1 minute period should be recorded (this will be the control data). Then the caffeine solution is added to the fish bowl, taking care not to pour undissolved chunks of pill binders into the fish

beaker (extraneous variable). This can be achieved by allowed solid particles to settle out, or preferentially, to pass through a cheese cloth as the solution is transferred to the fish beaker. Allow 5 mins working time for the compound effect to start. After this time lapse, gill movements should be quantified for 1 mins again. Students should also be encouraged to make observations of swimming speeds and patterns, as well as any other changes in behavior on their data sheet. Allow 5 mins time to pass and then record a second exposure data point of 1 min. Repeat for a third data point. Note: students were encouraged to make alterations to the experiment, for example, collecting additional data points, measuring cm swam rather than/in addition to gill movement.

5. Finally, the number of gill movements before caffeine administration, and during the three time points after caffeine administration, should be represented as a bar graph (each student makes their own- to be submitted along with data sheet). Each group should draw their graph on the board, and a discussion held of the variations in experimental design, and disparities in data between groups. A discussion should also be held as to the impact of the findings as they relate to fish health in the environment and long-term survival implications.

Homework: Completion of lab reports in scientific format (including the graph) for submission the following week.

Potential Project Variations:

1. Have different groups do different concentrations of caffeine and as a class produce a dose-response curve.
2. Can use crickets or Daphnia to repeat the experiment for a comparison of invertebrate to vertebrate reactions to caffeine.

Anticipated Results:

Goldfish exposed to caffeine should have approximately 25% increase in gill movement.

Caffeine Experiment Worksheet

1. Introduction

Name some foods or drinks that contain caffeine.

Why do people ingest caffeine?

In what way could caffeine be dangerous to consume?

How will you measure the effect of caffeine on your fish?

What is the hypothesis of your experiment?

2. Materials and Methods

Describe how you are going to carry out your experiment.

3. Results

Number of gill movements before caffeine	
Number of gill movements 5 mins after caffeine	
Number of gill movements 10 mins after caffeine	

Graph your data onto a bar graph.

4. Conclusions

What happened to the fish exposed to caffeine?

How has this experiment made you feel about your own caffeine use?